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CHAPTER 3 HABITAT CONNECTIVITY

Wildlife/vehicle accidents are a major cause of injury and property damage to the motoring public and a significant cause of mortality to wildlife species. In addition to these safety issues, highway corridors both directly destroy wildlife habitat and effect large-scale changes to topography and natural drainage patterns, which can have far-reaching downstream effects. A wide range of pollutants is also associated with highways including noise, vibration, light and chemical. Lastly, highway corridors divide natural habitats, Figure 3.1, into smaller patches and create barriers between these remaining patches. This process is known as habitat fragmentation and it is the greatest ecological impact posed by highway corridors. Highways effectively form barriers that include both physical barriers (the ability to safely cross the pavement) and behavioral barriers (many sensitive species avoid roads entirely). Habitat fragmentation can have two primary effects on wildlife: first, it can reduce the sizes of habitat patches so much that they can no longer support viable populations of some species; second, habitat fragmentation can isolate the remaining patches so that animals have a low chance of moving between patches. Being unable to move between patches renders species vulnerable to local and regional extinction.

Figure 3.1 Habitat fragmentation as seen in this photo taken from Picacho Peak showing Interstate 10 cutting in between Picacho Peak and Hayes Peak.

3.1 CHAPTER GOALS

Habitat fragmentation may be caused by numerous human activities, which are often planned in relative isolation from larger ecological processes. Highway corridors as a cause of habitat fragmentation is typically not understood until after significant damage has occurred, often in the forms of injured motorists and diminished wildlife populations. The general and scientific communities are becoming increasingly aware that this issue has not been sufficiently addressed in the past and that current highway planning efforts are typically too limited to address larger ecological issues. There is growing public interest in mitigating roadway impacts to wildlife and ecosystems. The goal of this chapter is to review the means by which highways can be made more permeable to wildlife movement and render them safer for both motorists and wildlife.

3.2 SCOPING AND NEPA PROCESSES

The approach recommended by this manual for planning new or upgrading existing highway corridors adopts the strategy that prevention is better than the cure regarding the negative effects of habitat fragmentation. When possible, designers should avoid alignments that lead to habitat fragmentation that then require mitigation. Therefore, during the scoping process the project team should first evaluate the natural heritage of the project area and identify sensitive areas. Time and funding required for gathering this information should be included in the scoping process. Appropriate information may include the following:

- Habitat types and sizes as well as existing and/or planned manmade facilities.
- Species and approximate sizes of populations that might be affected by construction of the highway.
- Existing wildlife corridors.
- Types of anticipated conflicts between wildlife (small and large species) and the highway corridor.
- The potential for effective mitigation of impacts caused by the highway.

Efforts must be made to maintain linear elements (such as riparian areas) that serve to funnel wildlife and that connect habitats and wildlife populations. These key areas should be mapped in order to illustrate possible effects of alternative highway routes. Points of conflict between natural processes and suggested alignments should be noted. At these points of conflict, begin evaluating possible design mitigation measures (see below). Doing so early in the scoping process can greatly improve the effectiveness of these measures and save significant construction costs. If the planning process proves it impossible or impractical to avoid points of conflict and additional mitigation measures are required, compensating environmental measures should be considered as a last resort. This approach forces infrastructure planning to look outside of the normal easement and to examine the development of the whole infrastructure network in relation to wider land use issues. As will be discussed throughout this manual, a cooperative, iterative method best addresses highway corridor concerns as they relate to wildlife issues. Wildlife and conservation biologists, landscape ecologists, planners, landscape architects and road engineers all have a valuable role to play throughout the scoping and design process. The multidisciplinary process will lead to recommendations of routing and alignments, planning of mitigation measures and other types of environmental adaptations.

Figure 3.2 Highway following the natural contours.

Other planning considerations:

- A roadway alignment that follows the natural contours of the project area, Figure 3.2, will typically present fewer obstacles to wildlife movement than an alignment that requires substantial earthwork and drainage structures.

Figure 3.3 Reducing speed by designing with steeper grades.

- When constructing a new roadway in areas of significant biological value, consider relaxing design standards without compromising safety. For example, in mountainous terrain, consider reducing the design speed to allow steeper grades. Figure 3.3, and tighter turning radii, both of which will reduce disturbances to the adjoining landscape.
- Consider ways to increase wildlife permeability at every opportunity. As will be discussed below, bridges are superior to embankments and culverts. Drainage culverts can be made to accommodate both wildlife and water flows.
- Where possible, choose an alignment that screens vehicles from adjoining areas, thereby preventing light and noise pollution from spilling beyond the easement. A natural or artificial berm or vegetative screen can also be effective (see Figure 3.4).
- Widening or improving existing roads should be reviewed as an opportunity to increase habitat

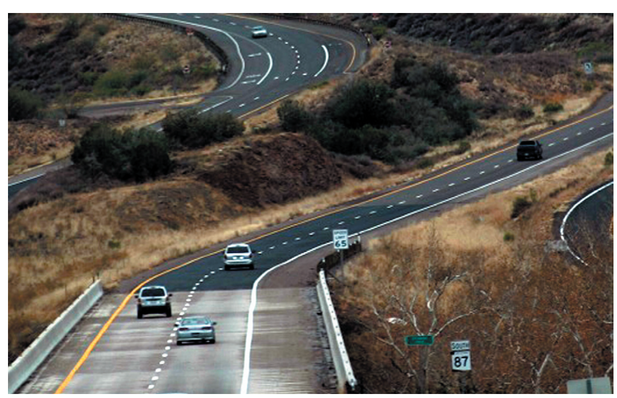

Figure 3.4 Vegetation and berms can screen light pollution.

Figure 3.5 With larger dimensions, long spans between bridge supports can have less of an impact on sensitive wildlife corridors while allowing traffic to move overhead.

connectivity, particularly since upgrading typically increases the barrier effect of the corridor. While direct habitat loss is unavoidable with highway construction/upgrading, a mitigation plan that strives to moderate adjacent habitat affects and facilitate safe movement of wildlife across the highway (highway permeability) is a key step in softening these ecological effects. In particular, reducing the barrier effect by maximizing highway permeability is an important objective of the highway design process.

- Recognize that one of our ultimate goals is ecosystem health while implementing a roadway system.

3.3 DESIGN PROCESS

As discussed above, the first strategy for minimizing habitat fragmentation should be to avoid sensitive habitats. Where points of conflict occur between proposed highway alignments and the natural environment, general infrastructure planning should occur early in the planning process. The specific mitigation techniques that are described below should be viewed as small parts of an integrated solution. The selection of the most appropriate types of fauna passages requires consideration of the landscape, habitats affected and target species. There is rarely just one measure that will effectively mitigate habitat fragmentation. Different species require different mitigative measures and design criteria: one size does not fit all. Instead, a package of integrated measures is required that address problems at specific sites and for the corridor as a whole. These measures should be cost-effective, properly located, and sensitive to anticipated future land use changes bordering the highway.

General considerations include the following:

- Modifying engineering structures is often the most appropriate way to reduce the barrier effect of existing roads. Many such adaptations are not costly but can significantly increase the permeability of the corridor as will be discussed below.
- Larger dimensions, Figure 3.5, facilitate joint use by both humans and many different species of wildlife.

- A large number of adapted passages may, in some cases, give better results than constructing one new specific passage for the same price.
- Modification of maintenance procedures (e.g. treatment of vegetation) may improve the situation.
- Designs for structures that encourage safe wildlife movement continue to evolve as new information is brought forth and it is critical that new information continue to inform the design process. Therefore, provisions should be made during design for the installation of monitoring tools such as cameras that are activated by passing wildlife. Costs associated with monitoring are modest when compared to the overall expense of most structures.

Fauna Passages
Animal passages may be broadly categorized into overpasses and underpasses. There are few general guidelines regarding their choice. Vegetation grows more easily on overpasses and for that reason can provide a greater number of microhabitats. A wider range of species may therefore use them. Creative design to accommodate the species of concern is encouraged and may provide mitigations that minimize the impacts to the highway facility.

Wildlife Overpasses
Wildlife overpasses, Figure 3.6, are bridges built over the highway corridor. Although they can be a costly but effective means of minimizing the fragmentation effect of the roadway, in some cases it is actually cheaper to construct an overpass than an underpass due to terrain constraints.

- The wider an overpass, the more wildlife species it can encompass.
- Width, design and vegetation depend largely on the target species, which are usually ungulates or other mammals. Overpasses have also been shown to act as guiding lines for birds, bats and butterflies, not only enhancing the movements of flying animals that may be reluctant to cross open ground but also acting to reduce animal mortality.
- Overpasses can be better integrated into the surrounding landscape where the corridor creates a through-cut. Where the level of the overpass is higher than the adjoining land, the grades of the access ramps should be consistent with nearby natural grades.
- Costly structures such as overpasses should not be constructed for only one target species; the aim should be to connect habitats at the ecosystem level. This requires at least partial simulation at the overpass of the habitat on both sides of the corridor.
- A standard width of 120-150 feet is recommended. Smaller widths will provide movement only to less sensitive wildlife and widths less than 60 feet have been shown to be less frequently utilized. The longer an overpass is, the wider it should be; a minimum width to length ratio should be greater than 0.8.
- Vegetation should typically reflect species on either side of corridor. A line of larger shrubs across the bridge can provide a guiding line, cover and protection from vehicular lights and noise.
- Screening at the sides, Figure 3.7, and approaches of the overpass aim to reduce

Figure 3.6 Wildlife overpass in Florida.

Figure 3.7 Screening at sides of wildlife overpasses.

disturbance from vehicular lights and noise and may be created from vegetation, earthen berms or manmade materials. Artificial screens are more important on narrow overpasses. High screens should be avoided in order to prevent creating a “tunnel” effect. In general, screens should reach about six feet in height.

- Paved bridges constructed for light local traffic that span highway corridors are rarely utilized by wildlife in order to cross highway corridors. However, these can be improved for wildlife by adding a three-foot wide strip of soil suitable for low vegetation. Where such joint-use bridges are designed, including a screen between the human and wildlife travelways will improve wildlife use.
- Fences are needed to guide animals to an appropriate fauna passage and will be discussed later in this chapter.

Wildlife Underpasses

Underpasses for wildlife include all types of structures built as connections under the level of the roadway. Many underpasses are constructed for purposes other than wildlife passage. However, with modest adaptations, these structures can function as successful wildlife passages and lessen the effect of habitat fragmentation.

Bridges

- Bridges typically cross natural drainages, Figure 3.8, and they are a valuable means for peserving riparian ecosystems . Natural drainages are preferred roads for many species of wildlife such as invertebrates and small vertebrates, which are strongly linked to particular vegetative types and which hardly use culverts without plant cover. Although they are more expensive than embankment slopes with culverts, bridges allow the preservation of valuable ecosystems.
- Even where natural drainages do not exist, “dry” bridges can be placed where needed to provide effective animal passage corridors.
- Cover beneath bridges, Figure 3.9, is critical to encourage movement by small species.
    - To allow plant cover under the bridge, the bridge deck should be a minimum height of 15 feet.
    - For wide roads, travelways can be separated to provide extra light to the area below.
    - Where lack of water and light will restrict vegetative growth, provide artificial cover such as piles of tree stumps or rocks. Do not cover the ground with gravel, riprap or pavement.

Figure 3.8 Bridge crossing a natural drainage, built high enough to preserve riparian ecosystem.

- Where the area under the bridge will serve both vehicles and wildlife, provide a screen between the two paths to shield wildlife from vehicular lights.
- Careful attention should be paid to embankment slopes.
    - These should remain outside of the drainage channel in order to provide wildlife with a relatively undisturbed means of movement.
    - Where embankments are constructed adjacent to perennial water sources, ensure that they are sufficiently set back from those water sources to provide wildlife crossings that remain dry.

Figure 3.9 Cover beneath bridges is critical for animal movement.

Figure 3.10
Placing a bat box under a bridge.

- Some wildlife species (e.g., bighorn sheep) prefer to migrate along the sides of drainages. Therefore, attention should be paid to embankment slope materials (concrete, riprap, gravel, soil) and slope ratios (vertical versus battered). For some wildlife species, these materials may form a barrier to movement.
- For wildlife species that prefer the sides of drainages or where embankments encroach into the natural drainage channel, provide three- to five-foot wide walkways across those embankments.

- Bridges can be fitted with bat boxes, Figure 3.10, of various designs, which can be placed on both girder as well as cast-in-place type structures. It is recommended that bat boxes not be placed over live streams and should be placed at the abutment ends of the bridges a minimum of 10 feet from the ground to prevent vandalism.
- The tops of bridge abutments can appear to prey species to offer suitable ledges from which predators can ambush. Therefore, carefully consider the design and locations of abutments. If less than eight feet high, set abutments back from likely wildlife trails.
- If greater than eight feet high, set abutments back from one another sufficiently to avoid creating a "tunnel" effect.
- To reduce tunnel effect, an open median is recommended wherever feasible for better day lighting.
- Wildlife fences should be considered to funnel wildlife species under the bridge.

Box Culverts

Where possible consider the following:

- Box culverts, Figure 3.11, can be designed to allow the safe passage of large mammals. Target species include deer and large carnivores such as coyotes and mountain lions.
- Box culverts are less suitable than bridges for connecting habitats because the lack of water and light allow for only limited vegetative growth. In addition, boxes typically provide only limited visibility through and escape venues from the structure, which may deter prey species. Construction of boxes also permanently disturbs native vegetation and disrupts streambed morphology.
- Culverts should be located along wildlife corridors identified during the planning process. Where culverts cannot be located directly on the corridor, linking passages to the corridor is essential.
- The longer an underpass is, the wider and higher it will have to be. In general, recommendations for dimensions include a minimum width of 45 feet and a height of 10 to 12 feet. A loose measure for dimensions can be calculated by multiplying width by height and dividing by length. This product should not be less than 1.0. When this value is less than 1.0 consider other structure options.
- The fact that longer underpasses are dark may present a barrier to wildlife movement. If possible, introduce natural light by means of intermediate grates overhead (in general, artificial lighting has not been successful). Sound barriers at these grates for vehicular traffic may improve the function of the underpass.
- The grade of the culvert should not exceed five

Figure 3.11 Box culverts can be designed for larger species to travel through.

Figure 3.12 Culverts should be free of obstacles.

Figure 3.13 Small pipe culvert.

percent.

- The floor of the culvert should be soil.
- The vegetation at the entrance of the culvert should be attractive to the target animals. Vegetation at these locations can also serve to screen wildlife from vehicles.
- If possible, provide earth berms or other means to screen entrances from traffic noise.
- Vegetative cuttings or stumps can be placed inside the culvert to create cover for small animals.
- Access to the culverts, Figure 3.12, should be level and free of obstacles for small animals. When designed to also accommodate drainage needs, culvert outfalls are typically protected against erosion. This protection (such as riprap) may form a barrier to wildlife movement. Therefore, provide a means for wildlife access. For example, where riprap is used, grouted riprap pathways may be constructed where the riprap meets the culvert headwall. Avoid the use of ungraded large riprap, which can act as a barrier to smaller wildlife species.
- If the culvert is to be jointly utilized by both humans and wildlife, create separate corridors for each separated by a screen.Fences should be constructed to lead animals toward the underpass (see following pages).

Small Culverts

- Underpasses constructed for small animals consist of pipes, Figure 3.13, or small box culverts with a diameter/width of one to six feet.
- Pipes are often less expensive than box culverts and are easier to install under existing roadways. However, small box culverts are preferable for amphibians and possibly for other small species because the vertical walls provide better guidance.
- Pipe diameters need to be sufficiently large to allow for a level (flat) traveling surface. Ideally, this surface is as natural as possible such as soil and rock. Maintenance is more difficult with smaller diameter pipes.
- Culvert slopes that exceed five percent will not be utilized by most wildlife species.
- Concrete or metal pipes can be used for underpasses, but some species (such as rabbits and some carnivores) will avoid contact with metal surfaces.
- Small culverts dedicated exclusively to small wildlife species should always be considered.
- Where the underpass also acts as a drainage culvert that regularly flows, the structure must be adapted to keep a dry travelway. This can be achieved by means of an internal embankment or ledge.
- Culvert entrances should be located in recesses along the fence line so that animals are guided to them. Access to the entrances needs to be kept clear of obstructions, but also provide cover.
- When designed to also accommodate drainage needs, culvert outfalls are typically protected against erosion. Graded riprap is preferred to smooth concrete to facilitate movement by small animals. Avoid the use of ungraded large riprap, Figure 3.14, which can act as a barrier to smaller wildlife species.
- The outfall slopes should be less than 45

Figure 3.14 Ungraded large riprap can act as a barrier to smaller wildlife.

degrees.

- The invert elevations of both inlet and outfall should match that of the adjacent grade.

Fish Passages

Fish passage includes bridges, Figure 3.15, and box and pipe culverts. This section includes general guidelines for culverts only. For all drainages where fish are found, consult a wildlife specialist.

- The optimal location for a fish passage will be where the passage has the same water flow and bottom substrate as the main watercourse.
- In general, there are four main criteria to consider in the design of appropriate fish passage:
    - Not too long.
    - Not too steep.
    - Not too narrow.
    - No outfall drop.
- Of these, outfall drop is the most critical. For most species, drops greater than two to four inches will obstruct passage. The scour pool at the pipe outfall may form a good habitat, but it can create a barrier for upstream movement.
- It is also important to maintain flow velocities through the culvert that do not exceed flows in the natural stream. Therefore, the invert elevation of the culvert, should be below the level of the streambed.
- The alignment of the culvert should be similar to that of the natural stream. A culvert with an extreme skew (greater than 30 degrees to the stream) will affect the success of fish passage by increasing inlet contraction and turbulence. In-channel deposition and bank scour will also often occur, leading to stream degradation. Conversely, culverts that are not skewed may be considerably longer than one that is skewed.

Amphibian and Reptile Tunnels

Many species of amphibians and reptiles migrate to seasonal feeding and breeding areas. In doing so, they may cross roadways in highly concentrated numbers over relatively short periods of time. For this reason, passage structures can be temporary or permanent

Figure 3.15 This fish passage demonstrates the four main criteria: not too long, steep, and narrow, and no outfall drop.

installations.

- Permanent barriers can be erected that guide amphibians into tunnels. Small mammals may also utilize these underpasses.
- As discussed earlier in this chapter, if culverts are installed to convey perennial stream flows, adapt the culvert to include a permanently dry path.
    - Tunnels with rectangular cross sections are recommended over round pipes because vertical walls provide better guidance. If round pipes are utilized, provide a flat-bottomed traveling surface.
    - Culvert slopes should be less than five percent.
    - Concrete is superior to metal or plastic.
    - A top constructed of metal grating will allow natural light into the tunnel, which will provide better guidance.
    - Guiding structures or fences should be perpendicular to the groundplane and should be at least 16 inches tall. They should not be constructed of netting, which can trap animals.
    - The ends of the guides, Figure 3.16, should be U-shaped to prevent animals from leaving the fence. The top should be bent back in the direction of the animal.
    - Vegetation should provide cover but not obstruct the travelway adjacent to the guide structure.
    - Temporary barriers can be erected along migration routes that guide amphibians into buckets, which are dug into the ground. The animals are collected from the buckets and released on the other side of the roadway on a regular basis during the migration season.

Fences and Walls

Fences are typically erected to reduce accidents due to collisions between large mammals and cars. They can also serve to reduce the number of smaller animals killed on roads. The disadvantage of fences is that they can increase the barrier effect. Where fences or other barriers are erected, animal species will continue to need to cross the road. Therefore, they must be designed and constructed in combination with wildlife passages, Figure 3.17. In these cases, they fulfill an important role in guiding animals to the appropriate crossing points. When traffic safety is not an issue, fences should only be erected where highway mortality may threaten a population or sufficient crossing structures are in place to ensure permeability. Otherwise, the fence may have more negative effects on the survival of the population over time than mortality due to traffic.

- In general, fences should be constructed only in those areas where the number of animals is high or where there is a high risk of accidents involving wildlife. Therefore, they should typically be installed along high-speed, high-volume highways. On roads with low traffic density, fences should only be installed at high-risk locations. If fences are determined to be necessary, they should be installed along both directions of travel.
- The ends of fences are critical. Ideally, they should terminate at crossing structures such

Figure 3.16 U-shaped ends of guides can be seen in this successful tortoise tunnel on State Route 86.

Figure 3.17 Fence in combination with wildlife passage.

as bridges or at impervious natural surface (such as a steep slope). At a minimum, they should extend well beyond the known wildlife movement corridors. This distance will vary according to the target species. For example, for larger ungulates such as elk, deer or bighorn sheep, fences should extend one-half mile beyond the last crossing structure.

- Fence openings must be integrated with appropriate wildlife crossings. On lower-volume roads, fence openings can be installed at locations where drivers have sufficient sight distances to stop for crossing animals.
- Exits from within the easement, jump outs, must also be provided to allow for animals to escape. These should be placed at a minimum of ½ mile intervals and at the ends of bridge structures.
- Fence heights must be determined in relation to the target species, to the local terrain (can the animal jump from a nearby slope?) and to the potential for snow cover, which may reduce the effective height of the fence. In general, for larger species such as deer, elk or big horn sheep, fence height should reach at least seven feet. Extra wires attached to the top at 45 to 90 degree angles may be needed in order to reduce mountain lion jump-over.
- Fences are typically constructed of wire fence attached to metal or wood posts. To prevent smaller species from entering the highway, it may be appropriate to use a smaller mesh size at the bottom half or third of the fence (opaque barriers should be used for amphibians as discussed above). The bottom wire must rest directly on or be buried into the adjacent grade (e.g., to prevent dig-out by coyotes, install bottom of fence four feet below grade). Where constructed across drainages or changes of grade, more fence posts will need to be installed to follow that grade.
- Consider the aesthetics of fence design and installation. In wooded areas, it may be relatively easy to hide the fence behind existing vegetation. In more open habitats, it may be necessary to set the fence at a greater than normal distance from the roadway in order to disguise it's presence. The fence color should integrate with the project landscape.
- Provide sturdy fence structures to resist impacts from anticipated wildlife species.
- Short concrete walls (18 to 48 inches) can be effective in funneling smaller species. These herpetology (or "herp") walls, Figure 3.18, are typically smooth-faced and incorporate a small overhanging lip at the top of the wall to reduce climbing or jumping.

Roadside Vegetation
As will be discussed in Chapter 7 and 11, the reclamation of lands disturbed by highway construction is required for both aesthetic and environmental reasons. In general, disturbed soils are seeded with species native to the project ecology. Considerations regarding the selection of those seed mixes with respect to wildlife concerns include the following:

- Avoid including species of shrubs and trees that are attractive to large browsing mammals.

Figure 3.18 Herpetology wall will funnel small speciecs.

- In forested environments and outside the clear zone, consider including species of trees that can provide cover for birds and allow them to fly from one refuge to another while crossing the highway. Tall trees can lift their flight paths over the roadway.
- Dense vegetation of an appropriate height can serve to funnel animals toward appropriate crossing locations, similar to fences.

Maintenance considerations regarding right-of-way vegetation include:

- Cutting and/or mowing vegetation within the right-of-way to reduce possible forage for and improve driver visibility of large mammals.

3.4 ENVIRONMENTAL MITIGATION

Despite good planning and use of measures to avoid or reduce adverse impacts to natural habitats, it is impossible to completely avoid the negative environmental effects of highway corridors. Where those negative effects are determined to be excessive, environmental mitigation may be necessary. Mitigation in this sense is defined as creating, restoring or enhancing natural areas in order to offset ecological damages caused by the construction of a highway corridor. This mitigation should be considered as a “last resort” solution to be employed only when methods discussed above are determined to be insufficient. In contrast to those methods, environmental mitigation is generally constructed outside the highway easement area.

Mitigation measures should ideally aim to create similar ecological conditions to those that are impacted by the highway. Examples of environmental mitigation include restoration of degraded habitat (such as from over-grazing), restoration of damaged wildlife corridor (such as a riparian area) or a combination of these two to improve the connectivity of isolated habitat patches.

3.5 MONITORING

Monitoring devices, should be addressed during the NEPA and design processes and when appropriate included in the construction documents. As an integral component of the success of the structure as it contributes to habitat connectivity, monitoring should be included in the planning, design and, where feasible, the cost of the project. The particular monitoring requirements will have to be determined on a case-by-case basis as all projects are not the same. All in all, monitoring can contribute and help to facilitate an adaptive management approach to structure placement and efficient design in current projects and those in the future. One technique that has been utilized with some success for large structures is the installation of a built-in lockable box, within each wall. These boxes should be at least 1-foot square, include a removable door, and be pre-wired for solar, battery, or alternating current. This will provide for the least intrusive, most secure, most flexible, and most cost effective way to monitor wildlife usage of the various crossings, while minimizing human impact. Still photography or video cameras may be installed in these boxes and may be transferred between sites as required. Other monitoring equipment may be considered.

3.6 ADDITIONAL INFORMATION

Useful websites that provide additional information regarding habitat connection and wildlife crossing design may be found at:
http://www.wildlifecrossings.info/beta2.htm

Eco-logical: An Ecosystem Approach to Developing Infrastructure Projects:
http://environment.fhwa.dot.gov/ecological/eco_entry.asp

Keeping It Simple: Easy Ways to Help Wildlife Along Roads:
http://www.fhwa.dot.gov/environment/wildlifeprotection/index.cfm?fuseaction=home.

Safe Passage
http://www.carnivoresafepassage.org/

Arizon’s Wildlife Linkages Assessment
http://www.azdot/Highways/OES/AZ_Wildlife_Linkages/index.asp

Second Nature: Improving Transportation Without Putting Nature Second:
http://www.defenders.org/programs_and_policy/habitat_conservation/habitat_and_highways/resources/second_nature.php

Center for Environmental Excellance by AASHTO
http://www.environment.transportation.org/